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trucks, fitted with twin rings of double ball bearings of the Chapman type. The treads of the wheels are coned to the exact angle which will make their apexes all coincide with the point at the center of the plane of the circular trucks. Ease of revolution of the dome depends very largely upon the accuracy with which this adjustment is made and maintained. The necessary condition has been secured by attaching a small galvanometer mirror to the axis of each truck, and adjusting it normally. A theodolite mounted at the center of the dome then gave the reflections of its objective exactly centered on the cross wires, when the axis of the truck was brought to the proper direction.

*An Exhibition of a New Form of Frame for Straight Line Mathematical Models:*

Professor C. A. WALDO, Purdue University, Lafayette, Ind.

A new form of thread model for ruled surfaces was exhibited by Professor Waldo, the frame for the model being conformed to the surface of a sphere, thus permitting location of the points of attachment of the threads with much greater ease than in the ordinary forms in which the limiting surface is discontinuous. The method of construction was also explained.

*The Application of Mayer's Formula to the Determination of the Errors of the Equatorial:* Professor L. G. WELD, State University of Iowa, Iowa City, Ia.

Let the polar axis of the equatorial be rigidly clamped with the telescope first to the east and then to the west of the pier and the transits of three stars observed in each of these positions of the instrument. The clock correction being assumed known, the errors of azimuth, level (of declination axis) and collimation (in right ascension) may be obtained for each position by the use of Mayer's formula. From the two

sets of errors thus made known the mean azimuth error of the polar axis and the angle between this axis and the declination axis may be determined. The method is independent of the accuracy of the hour circle and may be used in correcting the setting of this circle upon the polar axis. When the hour circle is delicately graduated the data may also be used to determine the flexure of the declination axis.

LAENAS GIFFORD WELD,  
Secretary.

*ALBATROSS EXPEDITION TO THE EASTERN PACIFIC.\**

THE *Albatross*, under command of Lieut.-Commander L. M. Garrett, left San Francisco on the sixth of October and arrived at Panama on the twenty-second. I am fortunate in having as assistant for this trip Professor C. A. Kofoed, who has had great experience in studying the protozoa both in fresh water and at sea; he has been given charge of the collection of radiolarians and diatoms and of other minute pelagic organisms; and he will prepare a report on the results of that branch of the expedition. On the way along the coast Professor Kofoed took advantage of the opportunity for making surface hauls with the tow nets as well as vertical hauls, generally to a depth of 300 fathoms. A large amount of pelagic material was thus collected, not at a great distance from the coast, however. Off Mariato Point the *Albatross* made two hauls in the vicinity of the stations where in 1891 she found 'modern green sand,' in about 500 and 700 fathoms. It was interesting to find the green sand again, as the specimens collected in 1891 were lost in transit to Washington.

Immediately on reaching Panama the vessel was coaled and provisioned. On my

\* Extract from a letter of Mr. Alexander Agassiz to Hon. George M. Bowers, U. S. Fish Commissioner, dated Lima, November 28, 1904.

arrival there on the first of November I found her ready for sea, and on the second we left for Mariato Point to make a few additional trawl hauls in the region of the green sand. In both the hauls made off Mariato Point green sand was found, but not in the quantity obtained in 1891.

From Mariato Point we made a straight line of soundings towards Chatham Island in the Galapagos, intersecting the ring of soundings we made northeast of the islands in 1891. The deepest point of the line (1,900 fathoms) was found about 100 miles southwest of Mariato Point. The bottom then continued to show about 1,700 fathoms for nearly 200 miles and then shoaled very gradually to 1,418 fathoms about 80 miles from Chatham Island. From there it sloped quite rapidly, the 1,000-fathom line being not more than 60 miles from Chatham Island. We ran a short line south of Hood Island and found a somewhat steeper slope to that face of the Galapagos, reaching over 1,700 fathoms in a distance of less than 50 miles; the bottom then remained comparatively flat, attaining a depth of 2,000 fathoms about 100 miles further south. This depth we carried eastward on a line to Aguja Point; about half way the soundings had increased to over 2,200 fathoms, and remained at about that depth to within 60 miles of the coast, when the depth rapidly shoaled. From Aguja Point we ran a line of soundings to the southwest to a point about 675 miles west of Callao; on this line the depths gradually increased from 2,200 fathoms, 100 miles off the point, to nearly 2,500 fathoms. On running east to Callao the depth soon increased to about 2,600 fathoms, and at a distance of about 80 miles off Callao we dropped into the Milne-Edwards Deep and found a depth of over 3,200 fathoms. We spent a couple of days in developing this deep, making soundings of 1,490, 2,845, 458, 1,949, 2,338 and 3,120 fathoms; showing a great irregu-

larity of the bottom within a comparatively limited area of less than sixty miles in diameter. Thus far all our soundings have been made with the Lucas sounding machine.

In the Panamic Basin to the northeast of the Galapagos we trawled only off Mariato Point, but we occupied ten stations with the tow nets, hauling both at the surface and at 300 fathoms, and vertically from that depth; we also continued this pelagic work at nearly all the stations (35) from the Galapagos to Callao.

When off Chatham Island we began to trawl, and used the tow nets regularly, occupying 20 stations. The nets were in charge of Mr. F. M. Chamberlain. The pelagic collections, as a whole, are remarkably rich. They are especially noteworthy for the great variety and number of pelagic fishes obtained inside the 300-fathom line at a considerable distance from shore, from 300 to 650 miles. Many of these fishes had been considered as true deep-sea fishes, to be obtained only in the trawl when dredging between 1,000 and 1,500 fathoms or more. On one occasion the tow net brought up from 300 fathoms, the depth being 1,752 fathoms, no less than 12 species of fishes; of some species of *Myctophum* we obtained 18 specimens, of another 37, of a third 45; in all nearly 150 specimens. On other occasions it was not uncommon to obtain 8 or 10 species, and from 50 to 100 specimens. Among the most interesting types obtained in the tow net I may mention as coming from less than 300 fathoms *Stylophthalmus* and *Dissomma*, both of which Chun considers as deep-sea fishes, found in depths of 600 to 4,000 meters; also a species of *Eurypharynx* obtained for the first time in the Pacific. *Stylophthalmus* I had also caught in the tow net in 1900, during the tropical Pacific expedition of the *Albatross*, in depths of less than 300 fathoms. In the lines we ran across the

great northerly current which sweeps along the coasts of Peru and Chili and is deflected westward at the easterly corner of the Galapagos Islands, we obtained with the tow nets an unusually rich pelagic fauna at depths less than 300 fathoms. We collected a number of schizopods, among them many beautifully colored Gnatheuphausiæ, pelagic macrurans; huge, brilliant red copepods, as well as many other species of blue, gray, mottled and banded copepods. *Lucifer* and *Sergestes* were abundant in many of our hauls. Many species of amphipods were collected, hyperids without number, especially where the surface hauls were made among masses of Salpæ, which, on several occasions, formed a jelly of tunicates. Several species of Phronimæ also occurred constantly in the tow nets. Sagittæ were very numerous, a large orange species being noteworthy. Several species of *Tomopteris*, some of large size and brilliantly colored, violet or carmine with yellow flappers, and two species of pelagonemerteans, were taken. Two species of orange-colored stracods were also common, one having a carapace with a long spiny appendage. We obtained several species of pelagic cephalopods, *Cranchia* and *Taonius* among them. Two species of *Doliolum* also occurred, but they were never as abundant as the Salpæ, two species of which often constituted the whole contents of the net.

In the surface and deeper tows we procured a number of acalephs. We have thus far collected more than 50 species of medusæ and siphonophores, many of which have been figured by Mr. Bigelow, differing from those of the 1891 expedition. Atollæ and other deep-sea medusæ were common within the 300-fathom line.

The Salpæ guts gave us, in addition to the finer tow nets, immense collections of radiolarians, diatoms and Dinoflagellata, many of which have been considered to live

at great depth and upon the bottom. The number of diatoms found in this tropical region is most interesting. They have usually been considered as characteristic of more temperate and colder regions. On several occasions the surface waters were greatly discolored by their presence, and the extent of their influence on the bottom deposits is shown by the discovery of a number of localities where the bottom samples at depths from 1,490 to 2,845 fathoms in the track of the great Peruvian current formed a true infusorial earth.

The tow nets also contained many species of *Hyalea*, *Cymbulium*, *Styliolus*, *Cleodora*, *Tiedemannia*, *Clio* and the like. On one occasion the mass of the pelagic hauls consisted entirely of small brown copepods, the contents of the tow nets looking like sago soup. Another time Sagittæ, Salpæ, *Doliolum* and *Liriope*, all most transparent forms, formed the bulk of the tow net's catch. Still another time, *Firoloides* and *Carinaria* constituted the bulk of the haul. These catches, coming on successive days or interrupted with hauls of more than mediocre quality, show how hopeless it is at sea to make any quantitative analysis of the pelagic fauna and flora at any one station within the influence of such a great oceanic current as the Chili and Peruvian stream.

Hauls of the trawl made at the western extremity of our lines brought us within the area of the manganese nodules, with its radiolarian ooze mud, cetacean earbones and beaks of cephalopods; nothing could stand the damaging action of these nodules in grinding to pieces all the animal life the trawl may have obtained. Down to the depth of 2,200 fathoms or so the bottom was constituted of globigerina ooze, its character being more or less hidden when near the coast by the amount of detrital matter and terrigenous deposits which have drifted out to sea.

North of the Galapagos we found vegetable matter at nearly all the stations, and between the Galapagos and Callao such material was not uncommon in the trawl.

Beyond the line of 2,200 fathoms dead radiolarians became quite abundant on the bottom, as well as in the mud of the manganese nodules, though among the nodules it was not uncommon to find an occasional *Biloculina*. Many of the dead radiolarians obtained on the bottom Mr. Kofoid found in the guts of Salpæ swimming near the surface or within the 300-fathom line in the tow nets sent to that depth. The same is the case with many of the Dinoflagellata which have been considered as deep-sea types. In our tow nets from 300 fathoms we found very commonly *Tuscarora*, *Tuscarosa*, *Aulospira* and others. In depths of 300 fathoms to the surface the tow net was rich in Tintinnidæ, either dead or moribund Planktionellæ, and Dinoflagellata. Among the Dinoflagellata there were 10 species of *Ceratium*, 9 of Peridinidæ, *Goniaulix*, *Phalacrona*, *Pyrocystis*, *Cyttrocyla*, *Undella* and *Dictiocystus*. On the surface *Planktionella sol* predominates, with *Asteromphale*, *Bidolphia* and *Sunidia thalassothrix*; among the Dinoflagellata we obtained 12 species of *Ceratium*, 5 of *Peridinium* and 22 species of other Peridinidæ; among the Tintinnidæ were a number of Sticholonga; among the Acantheriæ were especially to be noticed *Acanthometra*, *Acanthostaurus*, *Amphilonche*, *Collozoum*, *Thalassicola*, a number of *Chirospira murrayana* and a few Challengeridæ.

Our trawls brought up from the bottom many interesting fishes, among which I may mention *Bathytærois*, *Ipnops*, and a few bat-fishes, all thus far described by Mr. Garman from the 1891 expedition. I may mention also a *Chimæra*, different from the Chili species. The fishes have been admirably cared for by Dr. J. C. Thompson, U. S. N.

Among the crustacea were *Lithodes*, *Munidopsis* and many macrurans, all well-known species of the 1891 expedition. We found a few mollusks and a few interesting genera of tubiculous annelids. Compared with the 1891 expedition, few starfishes and brittle stars were obtained, and still fewer sea urchins, only one species of *Aceste* and one of *Aerope*, a marked contrast to the numerous echini collected in the Panamic Basin in 1891. We obtained, however, a magnificent collection of holothurians, nearly every species occurring in the Panamic Basin being found in numbers in our track south of the Galapagos, in the wake of the great Chili-Peruvian current and at considerable depths. On one occasion, at station 4647, in 2,005 fathoms, we obtained no less than 16 species of holothurians, among them brilliantly colored *Benthodytes*, *Psychropotes*, *Scotoplanes*, *Euphronides* and the like. At station 4670, in 3,209 fathoms, we obtained 6 species of holothurians. At station 4672, in 2,845 fathoms, we also obtained very many specimens of three species of *Ankyroderma*, a large *Deima*, 2 species of *Scotoplanes*, 2 of *Psychropotes*, with a number of young stages of that genus; repeating thus the experience of the *Challenger*, which found holothurians in abundance at great depth, not only in the number of specimens, but also of the species, though the *Challenger* did not at any locality obtain as many as we did at station 4647. Mr. Westergren made a number of colored sketches of the species which were not obtained in the 1891 expedition. We also collected in the trawl a number of deep-sea actinians, none different, however, from genera found previously in the Panamic district. We also obtained a few pennatulids, gorgonians and antipathes, and a very considerable number of silicious sponges, usually associated with the holothurians found in deep water in the track of the Peruvian current. In the

track of the current at not too great distances from the coast we invariably brought, even from very considerable depths, sticks and twigs and fragments of vegetable matter. On two occasions we brought up in the trawl specimens of *Octacnemus*; the trawl had been working at 2,235 and at 2,222 fathoms. Both Moseley and Herdman described this interesting ascidian as attached to the bottom by a small peduncle. While the presence of the peduncle can not be denied, yet its attachment, if attached at all, must be of the slightest, its transparent slightly translucent body, with its eight large lobes, suggesting rather a pelagic type than a sedentary form. This ascidian was discovered by the *Challenger* west of Valparaiso.

Mr. Chamberlain made two daily observations of the density of the water, and found the same discrepancies between our observations and those of 1891, with those given by the *Challenger* and in the German Atlas of the Pacific Ocean. Whenever we took a serial temperature, he also determined the density at 800 fathoms. We occupied six stations for the serial temperatures, two on the western termini of the lines normal to the coast across the great Peruvian current, two in the center of the current, and two at a moderate distance from the coast. These serials developed an unusually rapid fall in the temperature between the surface and 50 fathoms—nearly  $12^{\circ}$  at the western extremity of the northern line, the temperature having dropped from  $71.7^{\circ}$  at the surface to  $59.2^{\circ}$ . At 200 fathoms it was  $51^{\circ}$ , and at 600 fathoms it had dropped to  $40.7^{\circ}$ , the bottom temperature at 2,005 fathoms being  $36.4^{\circ}$ . The temperature of the station in the central part of the current in 2,235 fathoms agreed with the western series. At the eastern part of the line, in 2,222 fathoms, with a bottom temperature of  $36.4^{\circ}$ , the surface being only  $67^{\circ}$ , we found

again a close agreement at 50 and 100 fathoms, the lower depths at 400 and 600 fathoms being from one to two degrees warmer than the outer temperatures. On taking a serial from the surface to 100 fathoms, we found that the greatest drop in temperature took place between 5 and 30 fathoms.

The temperatures of a line running due west from Callao showed a very close agreement both at the western end of the line, about 780 miles from the coast, and in the central part of the line, as well as in the shore station about 80 miles from the coast in 3,209 fathoms. The bottom temperature in nearly all the depths we sounded was  $36^{\circ}$ , a high temperature for that depth. I do not at present make any comparison with the serials taken in the Panamic district in 1891, but wait until we shall have completed our lines to the south and to the west.

We leave for Easter Island on the third of December, where we shall coal, and from there go to the Galapagos, and thence to Manga Reva and Acapulco, where we ought to arrive in the early days of March.

The changes made in the working apparatus of the *Albatross* under the superintendence of Lieutenant Franklin Swift, U. S. Navy, have proved most satisfactory. The alterations in the main drum and the device for preventing the piling of the wire on the surging drum and the accompanying shock, have greatly reduced the risk of breaking the wire rope when trawling at great depths. The wire rope has proved an excellent piece of workmanship, and has served admirably in the comparatively deep water in which most of our trawling has been done thus far. A new dredging boom has also been installed, and everything relating to the equipment of the *Albatross* has been carefully overhauled.

Lieut.-Commander L. M. Garrett has been indefatigable in his interest for the expedition; the officers and crew have been de-

voted to their work; and the members of the scientific staff have carried out most faithfully their duties of preparing and preserving the collections thus far made.

We hoped to be docked at Callao, but owing to the prolonged occupation of the dock by a disabled steamer and the uncertainty of its becoming free within reasonable time, we decided to proceed without further delay to Easter Island and continue the expedition as we are.

ALEXANDER AGASSIZ.

#### SCIENTIFIC BOOKS.

*Rational Geometry.* By GEORGE BRUCE HALSTED. New York and London, John Wiley and Sons. 1904. Pp. viii + 285.

For over two thousand years there has been only one authoritative text-book in geometry. 'No text-book,' says the British Association, 'that has yet been produced is fit to succeed Euclid in the position of authority!' There is, in fact, little improvement to be made in Euclid's work along the lines which he adopted, and among the multitude of modern text-books, each has fallen under the weight of criticism in proportion to its essential deviation from that ancient author.

This does not mean that Euclid is without defect, but starting from the discussion of his famous parallel postulate, the modern development has been in the direction of the extension of geometrical science, with the place of that author so definitely fixed that the system which he developed is called *Euclidean geometry*, to distinguish it from new developments. The defects of Euclid arise out of a new view of rigorous logic whose objections seem finely spun to the average practical man, but which are based upon sound thought. The key to this modern criticism is the doubt which the mind casts upon the reliability of the intuitions of our senses, and the tendency to make pure reason the court of last resort. Thus, the sense of point between points, the perception of greater and less and many other tacit assumptions of the geometrical diagram, are the vitiating elements on which modern criticism concentrates its objections.

As an evidence of the ease with which the senses can be made to deceive, take a triangle  $ABC$ , in which  $AC$  is slightly greater than  $BC$ . Erect a perpendicular to  $AB$  at its middle point to meet the bisector of the angle  $C$  in the point  $D$ . From  $D$  draw perpendiculars to  $AC$ ,  $BC$ , meeting them respectively in the points  $E$ ,  $F$ . Let the senses admit, as they readily will in a free-hand diagram, that  $E$  is between  $A$  and  $C$ , and  $F$  between  $B$  and  $C$ ; then from the equal right triangles  $AED = BFD$ ,  $DEC = DFC$ , we find  $AE = BF$ ,  $EC = FC$ , and, by adding,  $AC = BC$ , whereas  $AC$  is in fact greater than  $BC$ .

Are we to take our eyes as evidence that one point lies between two other points, or how are we to establish that fact? This query alone lets in a flood of criticism on all established demonstrations. The aim of modern rational geometry is to pass from premise to conclusion solely by the force of reason. Points, lines and planes are the names of things which need not be physically conceived. The object is to deduce the conclusions which follow from certain assumed relations between these things, so that if the relations hold the conclusions follow, whatever these things may be. Space is the totality of these things; its properties are solely logical, and varied in character according to the assumed fundamental relations. Those assumed relations which develop space concepts that are apparently in accord with vision constitute the modern foundations of Euclidean space.

Mr. Halsted is the first to write an elementary text-book which adopts the modern view, and in this respect, his 'Rational Geometry' is epoch-making. It is based upon foundations which have been proposed by the German mathematician, Hilbert. In point of fact, the book contains numerous diagrams, and is not to be distinguished in this respect from ordinary text-books, but these are simply gratuitous and not necessary accompaniments of the argument, designed especially for elementary students whose minds would be unequal to the task of reveling in the domain of pure reason. Also, in opening the book at random, one does not recognize any great difference from an ordinary geometry. In other words, those as-